DOCUMENT RESUME

ED 115 502 SE 019 935

AUTHOR Wish, Peter A.; And Others
TITLE A Report on an Instrument for Observing Classroom Science Behavior in the Elementary School.
PUB DATE 75
NOTE 14p.

EDRS PRICE MF-$0.76 HC-$1.58 Plus Postage
DESCRIPTORS Educational Research; Elementary School Science; Higher Education; Instruction; Preservice Education; Science Education; *Student Behavior; *Teacher Behavior; *Teacher Education
IDENTIFIERS Research Reports

ABSTRACT

The Instrument for Observing Classroom Science Behavior (IOCSB) describes and measures the frequency of classroom science behavior at the elementary school level. It was developed to study the relationship of science attitudes of preservice elementary teachers to subsequent performance in science teaching. During their student teaching period, 38 preservice elementary teachers were observed twice using the IOCSB. Two college teachers, experienced in elementary school science education, encoded teacher behavior as well as pupil behavior. The IOCSB is a six category instrument containing 33 sub-categories that are behaviorally defined and contain examples of what is intended by each behavior. This paper lists the behavioral categories, definitions, and examples used in the instrument. Behavioral item selection was based on several sources. The relevance of each behavior was rated by judges with categories 1-5 judged relevant and category 6 judged irrelevant. Reliability was estimated by obtaining measures of interobserver agreement between the investigator and the observers; an average of 76 percent was reached. The frequencies of relevant behaviors are compared to those of irrelevant behaviors for both teacher behaviors and student behaviors. Data analysis suggests the instrument be used in the areas of science curriculum development and evaluation in the elementary school and in associated research. (LS)

A REPORT ON AN INSTRUMENT FOR OBSERVING CLASSROOM SCIENCE BEHAVIOR IN THE ELEMENTARY SCHOOL

PETER A. WISH
Assistant Professor of Science Education
Campbell College, Buies Creek, North Carolina

AND

HENRY A. SHANNON
Associate Professor of Science Education Emeritus
North Carolina State University, Raleigh, North Carolina

AND

JOHN L. WASIK
Associate Professor of Statistics
North Carolina State University, Raleigh, North Carolina

The Instrument for Observing Classroom Science Behavior (IOCSB) is an instrument for describing and measuring the frequency of classroom science behaviors at the elementary school level. It was developed by the investigators in order to study the relationship of science attitudes of preservice elementary teachers to subsequent performance in science teaching as a dissertation project persuant to the Ph.D. in Science Education, North Carolina State University, Raleigh, N.C. The study involved 38 preservice elementary teachers (K thru 8) who were enrolled in the elementary education curriculum at Campbell College, Buies Creek, North Carolina. During their student teaching period in the spring semester of 1975, each student was observed on two occasions for approximatly two 30 minute observation periods using the IOCSB. Data were recorded by two outside observers making direct observations and immediate encoding of classroom science behavior.

Nature of the Instrument

The IOCSB is a six category science classroom observation instrument containing 33 sub-categories which were established through a combination of both deductive and inductive methodologies. The sub-categories are behaviorally defined and contain examples of what is intended by each behavior. The selection of behavioral items for categories 1.0 through 5.0 were based on the philosophies and objectives contained in the NSF curricular projects (SCIS- Science Curriculum Improvement Study, ESS- Elementary Science Study, AAAS- Science A Process Approach), the state adopted science textbooks for North Carolina levels K-8, and college level elementary school science methods textbooks. After an extensive survey of these three types of literature, 25 sub-categories of behaviors consistent with teaching the nature of science in today's elementary school were deduced. The 25 sub-categories were then sent to a panel of judges who were asked to rate the relevancy of each behavior for

teaching the nature of science in the elementary school. The selection of behavioral items for category 6.0 were established inductively as apposed to the deductive method used to establish categories 1.0 through 5.0. Two outside observers made 72 independent observations of student teacher science performance and were asked to list and describe in category 6.0 any behavior that could not be categorized in 1.0 through 5.0. These observations were recorded as Other Behaviors and grouped into nine sub-categories (6.1.....6.9). Thus, category 6.0 became those behaviors that were not relevant to teaching the nature of science in today's elementary school science program. The behavorial categories, definitions and examples used in the instrument are as follows:

1.0 Observational Behaviors

1.1 Examining----------by looking, touching, listening, smelling, or tasting of objects.

The teacher shows a variety of objects or gives a variety of objects to the childern and asks them how the objects feel, smell, taste or how they look or sound. They may be using such equipment as magnifying glasses, micro-scopes, dissecting kits, etc., in order to examine the objects.

1.2 Communicating----- the meaning of new terms necessary for identifing and describing such properties of objects as color, shape, size, texture, sound, weight, etc.

The teacher discusses with the childern the meaning of such terms as color, shape, size, texture, sound, and weight. For example, the teacher might demonstrate how two objects differ in texture by describing one as smooth and the other as rough or have the childern rub the objects and state whether they are smooth or rough.

1.3 Identifying---------the properties of objects based on terms relating to their color, shape, size, texture, sound, weight, etc.

The teacher shows or gives the childern a variety of objects differing in color, shape, size, texture, etc., and asks them to describe the object in terms of their properties. For example, the teacher might ask the childern to describe some rocks or minerals as being rough or smooth, bright or dull, heavy or light, square or round.

1.4 Describing----------differences and similarities between two or more objects based on terms relating to such properties as color, texture, weight, temperature, etc.

After showing or giving the childern a variety of objects, the teacher asks them to state (or write) how the objects are similar or different in terms of color, shape, size, weight, texture, temperature, etc. For example, the

teacher shows or gives the childern a variety of objects and asks them to find the ones having a smooth or rough texture, triangular or square shape, and light or heavy weight.

1.5 Recognizing---------interaction between objects or systems by stating the changes in properties that have occurred.

The teacher or childern manipulate two or more objects in such a way as to cause an interaction and describe any changes in their properties. For example, the teacher might heat a variety of solid objects such as ice, lead, sugar, wood, etc., and asks the childern to describe the changes in terms of color, shape, size, texture, and weight.

2.0 Classification Behaviors

2.1 Organizing----------by sorting a collection of objects into groups (categories) based on similarities and differences in such properties as size, shape, color, texture, weight, etc.

The teacher gives the childern a variety of objects (paper shapes, blocks, animal pictures, leaves, buttons, etc.) and asks them to sort the objects according to a common property. For example, they might sort the objects into three groups (categories) based on the property of color.

2.2 Describing----------a collection of objects by constructing a bar graph representing categories of objects having similar properties.

The teacher might have the childern organize a variety of objects into groups (categories) based on some common property. The teacher and/or childern count the number of objects in each category and construct a bar graph that represents the collection of objects. For example, the teacher might give the childern a variety of different colored minerals and asks them to sort the minerals according to similarities in color. The teacher and/or childern will then construct a bar graph by drawing different colored lines (bars) to represent the various categories of colored minerals. The height of the bar will correspond to the number of minerals in the category.

2.3 Constructing--------a classification system by identifying the properties that will be used for forming categories and sub-categories.

The teacher asks the childern to identify the properties that will be used as a basis for sorting objects into a particular category or sub-category. For example, after showing the childern pictures of plant and animal life, the teacher asks the childern to identify the property that could be used as the basis for sorting the pictures into two main categories (Plant vs.

Animal). The childern are then asked to identify properties that can be used as a basis for sorting plants and animals into sub-categories; for example, non-flowering as opposed to flowering plants or animals with hair as opposed to animals without hair.

2.4 Demonstrating--------the use of a classification system by identifying the category and/or sub-category to which a new object belongs.

The teacher might have the childern assign a new object to a previously established classification system, For example, given the picture of a plant or animal not used in the original construction of the classification system, the teacher asks the childern to identify the category and sub-category to which it belongs. The teacher or childern may do this verbally or by physically placing the picture in the appropriate class.

3.0 Measurement Behaviors

3.1 Describing----------variables of objects or systems using values obtained by making relative comparisons to other objects, body senses or pictorial representations.

The teacher demonstrates the operations for obtaining measurements of length, area, volume, etc., by making relative comparisons to spans of strings, books, marbles, etc. Or the teacher may have the childern perform the operations themselves by measuring distances with spans of strings, covering an area with books, or counting the marbles that fill a container.

3.2 Describing----------variables of objects or systems using values obtained by performing operations with standardized measurement scales such as those used in the metric system for measuring length, volume, temperature, etc.

The teacher demonstrates the operations for obtaining measurements of length, weight, volume, temperature, etc., by making comparisons to standardized reference units such as centimeter, gram, milliliter, celsius etc. The childern may perform the operations themselves by using the celsius thermometer for measuring the temperature of a liquid or a meter stick for measuring the length of an object.

4.0 Prediction Behaviors

4.1 Forcasting----------a future event after observing a set of events.

After observing events associated with a teacher demonstration, a film, pictures, or an outdoor activity, the teacher and/or childern forcast a future event. For example, they may predict how long a candle will burn under various size jars, the stopping distance of an object which rolls or

slides down an incline from various heights, weather conditions after observing changes in cloud cover, air temperature, and wind direction or the effect of removing certain trees from a forest on animal life.

4.2 Forcasting----------a future event after analyzing data.

The teacher might present data in tabular form, or have childern collect data, and asks them to predict a future event. For example, they may predict weather conditions after analyzing data taken from barometers, psychrometers, and thermometers. They may predict health conditions after analyzing data on nutrition or they may predict the effect of a nuclear power plant on water quality after analyzing data taken from an ecological study.

4.3 Forcasting----------a future event using graphs to interpolate and extrapolate guesses.

For example, after graphing experimental data and finding that it takes three metal washers on one side of the scale to counterbalance one marble on the other side, and nine washers to counterbalnce three marbles, the teacher and/or childern predict that six washers will counterbalance two marbles (interpolate), and twelve washers will counterbalance four marbles (extrapolate).

5.0 Experimental Behaviors

5.1 Selecting a Problem-----by raising relevant questions after observing objects or events associated with films,demonstrations, pictures, etc., or after analyzing data organized into tables, graphs, or charts.

The teacher raises questions subsequent to childern observing an object or event associated with a demonstration, film, pictures, etc., or after analyzing relationships among variables expressed in graphical or tabular form. For example, after showing a wilting plant to the class, the teacher may ask "what things (factors) affect the growth of plants"?

5.2 Formulating Hypotheses---by identifying the various factors that might be related to an observed event and predicting their effects.

The teacher asks the childern to suggest some possible causes of an observed event. For example, childern might suggest such things (variables) as water, temperature, light, soil, etc., as forces that might affect the growth of plants. The teacher and/or childern list the factors and indicate how they might affect plant growth.

5.3 Structuring Test---------for the hypotheses by focusing on one or more relevant

factors that might be related to an observed event.

The teacher asks the childern how they might test their hypotheses. In some cases (K-3 levels), the teacher may suggest investigations which show the effect of a single variable, as for example, the watering of one plant and not the other. In other cases (intermediate levels), the teacher may suggest investigations that show effect of two or more variables, as for example, the effect of both water and light on plant growth.

5.4 Controlling and Manipulating Variables--by constructing two situations in which all conditions are similar except one.

The teacher discusses, with the childern, the possibility of factors that might effect the observed event other than the one under investigation. For example, the teacher might ask the childern, "How can we be sure that sunlight and not something else is affecting the growth of the plant?" Subsequently, the teacher might give a demnostration in which all conditions are similar for both situations except for sunlight or the childern may actually setup both controlled and experimental situations by placing one plant in a light area and the other in the dark. The teacher and/or childern may be involved in a planning activity, prior to the actual experiment, whereby the teacher and/or childern are involved in actually making the materials necessary for controlling and manipulating variables.

5.5 Demonstrating Use of Apparatus-- necessary for observing, measuring, and controlling variables.

The teacher might demonstrate procedures for using apparatus or guide childern in the effective use of such equipment as microscopes and magnifying lenses or measuring devices for determining length, weight, volume, temperature.

5.6 Making Operational Definitions---by describing the operations necessary for measuring a variable in qualitative or quantitative terms.

The teacher may ask the childern, "How will we know that water is affecting the growth of plants?" Plant growth may be suggested as being an increase in the height of the plant thus calling for some measurement of length. Defining other variables such as water (how much), sunlight (how much and when), may also be suggested by the teacher or childern.

5.7 Testing the Hypothesis---------by conducting the experiment.

The teacher may perform the actual experiment as a demonstration or have individuals and/or small groups carry out the experiment.

5.8 Gathering Data----------by recording observations on graphs, charts,

tables, etc., or planning how and when data will be gathered and analyzed.

The teacher may ask the childern to record observations made during a demonstration or have childern record observations from their own experiments using charts and tables. For example, they may record data on plant growth. They may be prepared for the collection of data by making the necessary graphs and charts to analyze the data and, in turn, may be exposed to the use of a simple statistic such as the mean.

5.9 Interpreting Data----by explaining results of an experiment for the purpose of accepting or rejecting the hypothesis.

After observing a demonstration or completing an experiment, the teacher and childern discuss the results and interpret their observations as either accepting or rejecting a hypothesis. For example, the teacher or childern might interpret an increase in plant height as being related to varying amounts of water and thus make their hypothesis acceptable.

5.10 Communicating--------experimental techniques or results by using films, television, reading materials, demonstrations or writing individual and/or group reports.

The teacher might use television programs, a film, relevant reading materials or demonstrations for introducing the childern to the meaning of an experimental technique or have childern report the results of an experiment in written form. For example, the teacher might ask the childern to read about an experiment in a science textbook and then describe the experiment verbally or in written form. The teacher might ask the childern to report on the procedures and results of an experiment in verbal or written form.

5.11 Reading----------by assigning carefully selected topics in textbooks, newspapers, magazines, etc., after an experiment.

The teacher assigns selected readings from textbooks, newspaper, and magazines, that relate to the concepts and principles that were investigated in the experiment. For example, after experimenting with the effects of sunlight on plant growth, the teacher might ask the childern to read an article concerning factors affecting plant growth taken from several library sources.

6.0 Other Behaviors

6.1 Questioning----------Teacher and/or pupils ask closed ended questions. Questions pertaining to previous learning (review type) would fall into this category.

6.2 Answering----------Pupils recall from memory. Teacher and/or pupils recall answer from previous lesson, after reading

literature, or reading from blackboard, etc.

6.3 Listening and Watching---Teacher and/or pupils passive. They may be listening to or watching a film, demonstration or other students participating in an activity.

6.4 General Overt Behavior----------The teacher and/or pupils may be engaged in such activities as role playing, singing songs; writing an assignment associated with a textbook task, boardwork, reports, showing films, drawing pictures and diagrams, and preparation of bulletin boards.

6.5 Reading----------From filmsrips and/or filmloops, from textbook, blackboard, overlays, and assigned reading tasks.

6.6 Management Information and Directions- The teacher gives information or directions for carrying out an activity and the pupils carry out instructions. The teacher may perform classroom managerial tasks, guide activities of class, small group, individuals and circulate throughout the classroom.

6.7 Discipline----------Behavior and forces which interfer with the learning climate of the class are recognized by the teacher and students and appropriate measures are taken.

6.8 Discussion----------Teacher and/or pupils are explaining or clarifying the meaning of a theory, principle, concept, technique, through the use and pertinent information. Discussion may flow from teacher to pupil or pupil to pupil.

6.9 Non-Functional--------Behavior bearing little or no relationship to learning activity.

The unit of encoding is a delayed time interval of one minute taken over a 30 minute observation period. Behaviors that are judged to be predominent or representative over a one minute time interval are encoded into the sub-categories. The encoding record consists of a vertical column containing the 33 sub-categories and a horizontal row representing one minute time units for a 30 minute observation period. Teacher behavior as well as pupil behavior (and number of pupils involved) are encoded into the sub-categories using the letter "T" and/or "P" plus a numerical subscript for denoting teacher and pupil behavior respectively (figure 1).

Figure 1

Example of encoding record used in the IOCSB

TIME INTERVAL----------	1	2	3	4	----------	30
1.0 OBSERVATION BEHAVIOR						
1.1 Examining	T/ P20					
1.2 Communicating			T			
.						
.						
.						
5.0 EXPERIMENTAL BEHAVIOR						
5.1 Selecting a problem		T	T			
5.2 Formulating hypotheses		P_5	P_7			
.						
.						
.						
6.0 OTHER BEHAVIORS						
6.1 Questioning		P_{15}	P_2			
.						
.						
6.9 Non-functional			P_{11}			

T= Teacher behavior P= Pupil behavior #= Number involved

Table I

Estimates of instrument reliability obtained by computing percent of agreement between the investigator and two independent observers: Spring '75.

I + 01		I + 02		I + 01 + 02	
DATE	% AGREEMENT	DATE	% AGREEMENT	DATE	% AGREEMENT
4-14	97	4-21	80	4-21	73
4-21	82	4-30	60	5-09	78
4-23	70	4-30	69		
4-28	98	5-07	67		
4-28	67	5-07	87		
5-09	93	5-09	78		
AVG.	85	AVG.	73	AVG.	76

I = Investigator 01= Observer #1 02= Observer #2

Instrument Reliability

Two college level teachers, experienced in elementary school science education, were used to make the observations. Reliability was estimated by obtaining measures of interobserver agreement between the investigator and each of the outside observers. Due to the large number of sub-categories in the instrument, it was decided to simply compute the percent of agreement between the investigator and each of the observers. The mean percent of interobserver agreement between the investigator and observer #1 and #2 was 85% and 73% respectively. Estimates of reliability were taken at the beginning of the study and continued throughout the entire study period for a total of 12 different measures (Table-I). On two occasions, the reliability estimates were based on the percent agreement between all three observers and an average of 76% agreement was reached.

Instrument Validity

The selection of behavioral items (categories 1.0 thru 5.0) for the instrument was based on the philosophies and objectives contained in the NSF curricular projects, the state adopted science textbooks for North Carolina levels K-8, and college level elementary school science methods textbooks. After an extensive survey of these three types of literature, 25 sub-categories of behaviors consistent with teaching the nature of science in today's elementary school were deduced. Behavioral definitions as well as examples for each of the sub-categories were then developed and sent to a jury of experts in the field of elementary school science education. Four judges were asked to rate each of the 25 sub-categories on two demensions: one, the degree to which the behavior was relevant to teaching the nature of science in the elementary school; two, the degree to which the behavior was relevant to the main category to which it belonged.

The rating scale contained values from 1 to 9 and was divided into three classes; one, highly irrelevant 1-2-3; two, relevant 4-5-6; highly relevant 7-8-9.

When asked to rate the relevancy of the behavior to teaching the nature of science in the elementary school, the judges were in 100% agreement at rating all 25 sub-categories as being highly relevant (a rating of 7,8, or 9). The distribution of the 100 individual judgemental ratings showed the following breakdowns: a rating of "7" appeared seven times; a rating of "8" appeared 15 times; a maximum rating of "9" appeared 78 times. Only one sub-category (5.5) received an average rating among the four judges of less than 8.0 (Table II). When asked to rate the behavioral sub-categories as to the degree to which they are relevant to the main category to which they belong, the judges were in 98% agreement at rating all 25 behaviors as being highly relevant. The distribution of the 100 individual judgemental ratings showed the following breakdowns: a rating of "6" appeared two times; a rating of "7" appeared seven times; a rating of "8" appeared 29 times; a maximum rating of "9" appeared 62 times. Only two sub-categories (5.4; 5.11) received an average intraclass relevancy rating, among the four judges, of less than 8.0 (Table III). The judges were asked to comment on any of the 25 sub-categories, ie., to delete or change any behavior that would not be considered relevant for teaching the nature of science in the elementary school. No deletions or additions were received.

The remaining sub-categories in the IOCSB, 6.0 (Other Behaviors), were established inductively as opposed to the deductive methodlogy used to deduce categories 1.0 - 5.0. The two independent observers were asked to list and describe in category 6.0 any behavior that could not be categorized in 1.0 through 5.0. These observations were recorded as other behaviors and later grouped into 9 sub-categories (6.1....6.9). Thus, category 6.0 became those behaviors that were not relevant to teaching the nature of science in today's elementary school science program.

SUMMARIZATION OF DATA

The IOCSB was developed as a research instrument for a Doctoral dissertation that investigated the relationship of science attitudes of preservice elementary teachers to subsequent performance in science teaching. Therefore, data generated by the instrument were used to measure and describe the frequency of classroom science behavior in the elementary school. Classroom science behavior was defined as those behaviors (both teacher and pupil) that were consistent with teaching and learning the nature of science in today's elementary school. Consistent with this definition, this instrument was developed for the purpose of generating data that could be used to compute two separate indexes of science performance.

A ratio representing the level of science teaching performance is obtained by tallying the frequency of teacher behaviors across categories 1.0 through 5.0 and

Table II

Instrument Validity: average rating, among 4 judges, of the degree of relevancy of 25 behavioral sub-categories for teaching the nature science in the elementary school.

Behavioral code	Avg. Rating	Behavioral code	Avg. Rating	Behavioral code	Avg. Rating
1.1	9.0	2.4	8.5	5.3	9.0
1.2	8.75	3.1	8.5	5.4	8.75
1.3	9.0	3.2	8.75	5.5	7.75
1.4	9.0	4.1	8.75	5.6	8.5
1.5	9.0	4.2	9.0	5.7	8.75
2.1	9.0	4.3	9.0	5.8	8.75
2.2	8.50	5.1	8.75	5.9	8.75
2.3	8.75	5.2	9.0	5.10	8.25
				5.11	8.0

Rating Scale: Highly Irrelevant 1---2---3--- Relevant 4---5---6 Highly Relevant 7---8---9---

Table III

Instrument Validity: Average rating of the degree of relevancy that a sub-category has for it's respective main category.

1.0 OBSERVATION		2.0 CLASSIFICATION		3.0 MEASUREMENT		4.0 PREDICTION		5.0 EXPERIMENTATION	
Code	Rating	Code	Rating	Code	Rating	Code	Rating	Code	Rating
1.1	9.0	2.1	9.0	3.1	8.75	4.1	9.0	5.1	8.5
1.2	8.5	2.2	8.25	3.2	8.25	4.2	8.5	5.2	9.0
1.3	8.5	2.3	8.25			4.3	8.0	5.3	8.75
1.4	8.5	2.4	8.25					5.4	7.75
1.5	8.25							5.5	8.75
								5.6	8.50
								5.7	9.0
								5.8	8.75
								5.9	8.50
								5.10	8.50
								5.11	7.75

Rating Scale: Highly Irrelevant 1---2---3--- Relevant 4---5---6 Highly Relevant 7---8---9---

dividing by the tally of frequencies in category 6.0. This ratio represents the comparison of teacher behaviors consistent with teaching the nature of science in the elementary school to those behaviors not consistent with teaching the nature of science. If teacher behavior was encoded in more than one category during a single encoding period, the frequency is weighed so that the total number of tallies equal the number of encoding units (time intervals). For example, if teacher behavior appeared in two sub-categories during the same time interval, a frequency of .5 for each "T" is tallied. For the purpose of this research, the ratio was defined as the Science-Non-Science Teacher Performance Ratio.

A ratio representing the level of overall pupil science behavior is obtained as follows: first, the frequency of pupil behavior is tallied across each category and then multiplied by the average number of pupils involved; ie. displaying the behavior; second, a sum of pupil behavior (frequency in category times the average number of pupils involved) across categories 1.0 thru 5.0 is computed. This quantity represents the total pupil behavior consistent with studying the nature of science; third, the sum of pupil behavior in category 6.0 is then computed in the same manner as above. This quantity represents total pupil behavior not consistent with studying the nature of science; fourth, by didviding the sum computed across categories 1.0 through 5.0 by the sum computed from category 6.0, a ratio of pupil science behavior is achieved. This ratio was referred to as the Science-Non-Science Pupil Performance Ratio.

COMMENTS

Preliminary analysis of the data generated by the use of the IOCSB suggest that the instrument has the potential to be used in the areas of science curriculum development and evaluation in the elementary school and in associated research. For example, the behaviors can be used as a list of objectives for structuring the science curriculum in the elementary school. If a science curriculum emphasizes the development of observational and classificational skills at the K-3 level, the IOCSB can serve as an evaluation tool in order to ascertain whether teacher and/or pupil behaviors were observed in these categories. The assessment can simply be based on the percent of behaviors falling into categories 1.0 and 2.0 as opposed to behaviors in categories 3.0 through 5.0.

The IOCSB can also be used on other areas of research dealing with science teaching behavior. For example, in experimental research dealing with methodological variables, an investigator might desire to study the effect of a particular method (an inservice workshop, a new preservive science teaching preparation technique, etc.) on subsequent science teaching behavior. If the method was predicted to develop a higher level of teacher performance in the complex experimental behaviors in category 5.0, as opposed to the other behaviors in category 6.0, percentages can be computed and compared.